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DIVISION OF THE
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M. M. LEIGHTON, *Chief*
URBANA

REPORT OF INVESTIGATIONS—No. 155

AN INTEGRATED GEOPHYSICAL AND GEOLOGICAL INVESTIGATION OF AQUIFERS IN GLACIAL DRIFT NEAR CHAMPAIGN-URBANA, ILLINOIS

BY

JOHN W. FOSTER AND MERLYN B. BUHLE

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Charles W. Collinson

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AN INTEGRATED GEOPHYSICAL AND GEOLOGICAL INVESTIGATION OF AQUIFERS IN GLACIAL DRIFT NEAR CHAMPAIGN–URBANA, ILLINOIS[1]

JOHN W. FOSTER AND MERLYN B. BUHLE.

CONTENTS.

[1] Published with permission of the Chief, Illinois State Geological Survey, Urbana, Illinois.

ABSTRACT.

Electrical earth resistivity surveys, extensive test drilling, and the electric logging of borings near Champaign-Urbana have provided abundant information for geological study of glacial drift aquifers. This investigation makes possible and encourages an efficient development of the available groundwater resources for public, industrial, and domestic use throughout a three-hundred-square-mile area.

The basic geology of the bedrock surface and of the overlying Kansan, Illinoian, and Wisconsin drift mantles is described, together with the techniques of electrical prospecting on the ground surface, electric logging of rotary borings in glacial drift and the collection and study of drift samples. The integration of composite electrical data with geologic studies provides valuable information on the distribution, thickness, permeability, confinement, and origin of scattered water-bearing formations above the bedrock surface. Electrical and geologic cross sections show the regional relations of the aquifers with buried bedrock surface topography which includes the deep Mahomet (Lower Teays) valley.

The investigation yields information on numerous water-bearing deposits which are untapped and suitable for extensive industrial exploitation in addition to other aquifers available for municipal and domestic groundwater development. The Champaign-Urbana study—a type investigation—reveals the presence of buried sands and gravels whose potential groundwater resources within economic reach of the community greatly exceed total demand for the foreseeable future.

INTRODUCTION.

Introductory Statement.—The geology of the groundwater resources of the Champaign-Urbana area has been under investigation for more than twenty-five years. This long-term investigation plus a wealth of geological and geophysical data recently acquired is the basis for the present work. Attention is focused on the geologic conditions controlling the occurrence of groundwater in the unconsolidated glacial drift lying above the bedrock. It is the purpose of this paper to describe these geologic conditions and to present some of the geological and geophysical methods used to acquire the basic data.

The Champaign-Urbana area, in east-central Illinois, as here defined, is a rectangle fifteen by twenty miles, lying entirely within Champaign County and extending eastward from the Champaign-Piatt county line. It includes parts of twelve townships and contains the following communities in descending order of population: Champaign, Urbana, Mahomet, Bondville, Seymour, Mayview, Deers, Staley, and Sellers.

Topography and Drainage.—The land surface is a moderately level to rolling upland prairie with a maximum relief of about 210 feet. The highest elevations lie along the northwest trending Champaign moraine (Fig. 8), between Champaign and Mahomet, called Yankee Ridge. The highest point in the area (approximately 860 feet above sea level) is located in section 20, T.20 N., R.8 E., about six miles northwest of the Champaign city limits.

The water sheds of four drainage basins lie within these three hundred square miles. Drainage on the northeast and east is into a west branch of the Vermilion system, and on the south into the headwaters of the Embarrass.

These systems enter the Wabash, the Vermilion in Indiana, and the Embarrass in Lawrence County, Illinois. In the southwest portion of the area the surface drainage forms the headwaters of the Kaskaskia system which joins the Mississippi River fifty miles south of St. Louis. In the west and northwest portions the drainage enters the Sangamon system which in turn joins the Illinois River in northern Cass County.

Population.—The population in Champaign-Urbana dependent upon the privately owned Champaign-Urbana water distribution system is estimated by the Chamber of Commerce at 53,000. This figure is exclusive of more than 19,000 transient University of Illinois students whose water requirements in living quarters are met in part by the community system. The Mahomet

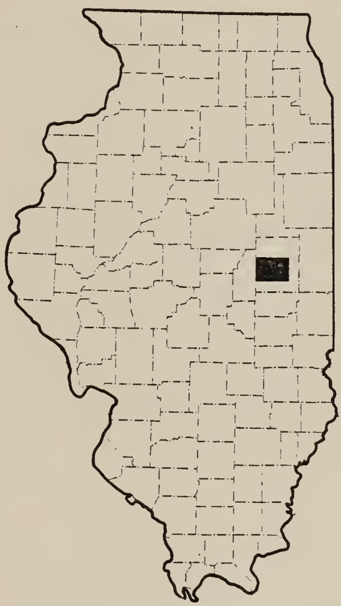

FIG. 1. Index map of the Champaign-Urbana area, Illinois.

village system serves about 800 persons. In the 300 square miles of the Champaign-Urbana area about 7,000 farm and hamlet dwellers (about eleven percent of total residents) are dependent upon individually developed groundwater supplies.

Geological Setting.[2]—No exposures of bedrock are known to exist in Champaign County. The pre-glacial and much of the glacial primary geologic data have necessarily been derived from sample studies of drill cuttings.

The glacial drift of the Champaign-Urbana area is underlain by Mississippian-Pennsylvanian bedrock. Regionally the area is on the north flank of the Illinois basin. Local geologic structure, however, controls the attitude of the bedrock strata from place to place. In the Champaign-Urbana area the

[2] See Figure 3 for geologic column.

beds dip generally east and west away from the axis of the LaSalle anticlinal belt (10, p. 442),[3] which trends roughly north-south across a large part of the state and crosses the west portion of the Champaign-Urbana area.

The bedrock strata directly underlying the drift are composed chiefly of lower Pennsylvanian shale with thin beds of limestone, sandstone, and coal in the Carbondale and Tradewater groups. Drilling near Mahomet, subsequent to 1931, encountered lower Mississippian strata below the drift along the axis of the LaSalle anticline. These beds are typically dark-colored shale of Kinderhook age. There are apparently no Devonian strata immediately beneath the drift in this area, although rocks of this age are known to occur directly beneath the drift at locations north and south of this vicinity along the anticlinal axis.

The thickness of the unconsolidated mantle ranges from about 50 to 440 feet and includes, in various parts of the area, pre-glacial, glacial, and interglacial deposits of at least six, and possibly as many as nine, ages. The drift is composed largely of pebbly, silty till and deposits of glacio-fluvial sand and gravel that have various areal and cross-sectional patterns.

Some of the coarse clastic drift possesses sufficient porosity, permeability, continuity and thickness to yield groundwater to small-diameter drilled wells. These deposits are the glacial groundwater aquifers.

Nature of the Geological Problem.—Effort has long been directed in the Champaign-Urbana area toward the development of the groundwater resources available in the unconsolidated glacial drift. One of the functions of the State Geological Survey has been to study, here as well as elsewhere in Illinois, the composition of glacial drift, the configuration of the bedrock surface, and other geologic factors controlling the occurrence of groundwater.

The geological problem is two-fold in that it concerns both the exploratory and development phases of groundwater production. The exploration phase consists of ascertaining, by various means, surface locations that warrant test drilling in the search for permeable water-bearing sands and gravels. The development phase is concerned with optimum depths for screen settings, optimum screen length and slot sizes and, though perhaps not of great importance in this area, shooting and acidizing zones.

The geologic factors which are considered in estimating the suitability of a sand and gravel aquifer for development of water supply are its (1) thickness and extent, (2) permeability, (3) depth, (4) orientation with respect to the bedrock surface, (5) confinement in till, silt, and clay, (6) geologic and geographic relationship to aquifers already yielding groundwater, and (7) geologic relationship to other aquifers with respect to groundwater recharge.

A thorough solution of exploration and development problems, though geological in nature, cannot be achieved by geological methods alone. Their solution lies in the integration of abstract and empirical geophysical data with known geological information. By this means the limits of geological prediction are extended beyond those based upon geologic data alone.

[3] Numbers in parentheses refer to Bibliography at end of paper.

Public Water Supply Development.—Three systems of public water supply have been established in the Champaign-Urbana area, those of the cities of Champaign-Urbana, the University of Illinois, and the village of Mahomet.

The water works serving Champaign-Urbana is a privately owned single system installed in 1885 and was the result of an unsuccessful prospect for coal. A shaft was dug in north Urbana, but a water-saturated stratum made

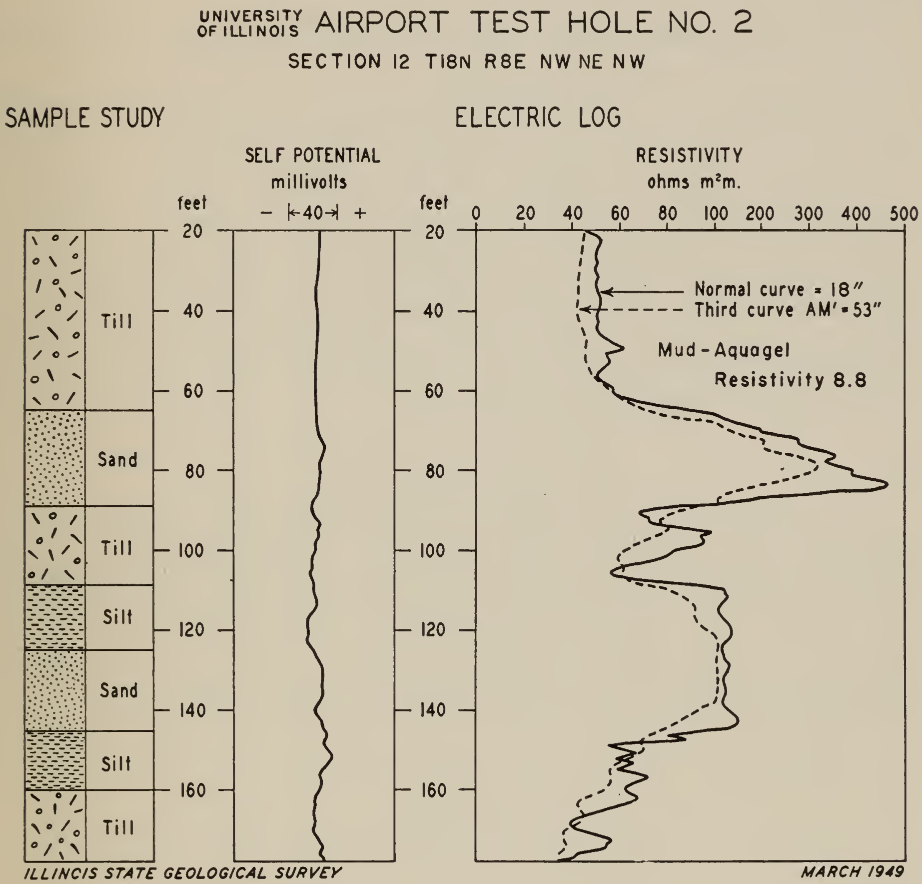

FIG. 2. Comparative sample study and electric log identifying zones of greatest permeability.

it impossible to develop the underlying coal resources. The original well field was located around the site of this shaft. This general field was further developed in 1915 and in 1921. By 1945 the water resources of the north Urbana well field area became alarmingly inadequate because of the demands of an increased population, and a search was begun for additional well fields. Geophysical and geological exploration by the State Geological Survey has led to recent drilling and development by the Illinois Water

Service Company of a new and more than adequate water supply one to three miles northwest of Champaign.

Until 1901 the University of Illinois was supplied its water by the private company furnishing groundwater to the cities. Because of inadequate fire protection to buildings on the University grounds, a separate water system was developed by the University. Its distribution system is so cross-connected with the cities' system that water is in emergency available to the University or to the cities from either source of supply.

The Mahomet water system, established in 1939, is supplied by two wells drilled less than 100 feet into glacial drift.

Acknowledgment.—The authors wish to acknowledge the fundamental work of the geologists who have made this paper possible, particularly Dr. Leland Horberg, University of Chicago, formerly of the Illinois State Geological Survey, and Dr. M. M. Leighton, Chief of the Illinois Geological Survey. Credit is due also to Dr. A. C. Bevan, Dr. George E. Ekblaw, Dr. M. W. Pullen, Dr. H. B. Willman, Mr. L. E. Workman, Mr. John F. Mann, of the Illinois State Geological Survey for helpful criticisms of the manuscript and illustrations, to Dr. Carl A. Bays, consulting geologist, for procedure suggestions during the early stages of the research, and to Mr. H. F. Smith of the Illinois State Water Survey for the hydrologic data which has been used in support of geological interpretation.

SOURCE OF GEOLOGIC DATA.

Subsurface Studies.—The study of drill cuttings, made possible by the permanent filing of earth samples by the State Geological Survey, reveals considerable subsurface information. The value of the information, however, is directly dependent upon the type of sampling method and the care employed by the driller. The cuttings are commonly from cable tool, rotary, or reverse hydraulic drill holes, taken at five-foot intervals. Studies have been made at the State Geological Survey of more than 92 sets of drill hole cuttings from the Champaign-Urbana area. Drill hole logs showing the Pleistocene strati-

University of Illinois Test, No. 4–1946, Layne Western, September 1946.
Sieve Analysis.

Sample	Percent retention on individual screens										50% retention	
	9	16	24	32	42	60	80	115	170	Pan	Diam. inches	Screen size
65–70	16.83	5.16	3.66	6.00	15.83	24.16	8.16	6.50	2.33	1.50	.0132	12
70–75	7.33	5.50	3.83	7.00	17.16	21.66	17.16	9.50	5.50	5.00	.0113	10
75–80	22.83	8.00	7.50	9.66	19.16	19.50	21.00	7.33	2.66	2.33	.0188	18
80–85	8.33	6.00	3.00	4.33	12.16	21.00	22.33	13.16	5.16	4.16	.0107	10
85–90	.16	.66	.50	1.50	6.83	3.50	43.33	28.16	11.50	3.83	.0074	7
125–130	1.33	.83	.83	2.66	16.33	19.00	26.66	17.33	7.33	7.33	.0087	8
130–135	1.66	1.00	2.00	7.33	35.33	25.66	7.00	3.00	16.00	1.00	.0130	12
135–140	.50	2.80	4.50	12.00	34.30	18.80	12.50	7.80	3.20	3.50	.0145	14
145–150	3.00	4.00	7.16	15.00	30.83	.33	26.33	6.33	2.66	3.50	.0114	10
150–155	9.66	27.83	11.66	12.50	16.66	3.83	9.33	3.00	1.66	3.66	.0267	25

graphy are drawn from sample study data. Drill hole logs include where feasible probable elevations of the glacial stratigraphic units and the elevation and description of the penetrated bedrock surface.

A mechanical analysis of grain size of the samples aids in establishing engineering specifications for screens in wells at the proper depths. These analyses provide the necessary data for selection of the optimum screen slot size usually based on a calculated 50 percent retention of aquifer material. No application has been made of sieve analysis data to stratigraphic correlations. The analyses data have been used chiefly in development problems of groundwater supplies.

Where samples of cuttings are not available or are incomplete, driller's logs may be of great value. In portions of Illinois, where drift overlies a continuous limestone surface, the driller's bedrock surface elevation is generally reliable. At many locations in the Champaign-Urbana area the bedrock is weathered shale; thence determination of the actual bedrock surface at such places may be difficult to establish. In such instances it is necessary to determine the bedrock surface elevations on the basis of sample study.

Surface Studies.—In groundwater problems surface studies of the glacial drift in the Champaign-Urbana area are limited in value because (a) cross-sectional exposures are commonly widely separated and apparently limited to Wisconsin drift; (b) the major water-bearing glacial deposits have no expression at the ground surface. The lithology of the shallow Wisconsin drift has considerable influence on the hydrologic characteristics of deeper aquifers. Our knowledge of the composition of even the upper drift sheet, however, has been principally derived from subsurface studies.

Surface observations have been largely topographic. In work on the geology of groundwater resources the major value of topographic and aerial data is their contribution to the knowledge of Wisconsin ice behavior.

SOURCE OF GEOPHYSICAL DATA.

The Electrical Earth Resistivity Survey.—Electrical earth resistivity surveys have been made intermittently in the vicinity of Champaign-Urbana over a period of 12 years beginning in 1938, but the first large comprehensive survey was completed in 1942 by Dr. K. O. Emery of the State Geological Survey. This survey consisted of an area 8 miles square with the twin cities in its approximate center (Figs. 9 and 10). In this investigation 540 stations were occupied. The second large survey was completed in 1944 by M. B. Buhle as a southward extension of Emery's survey. This extended the previous survey three miles. Both surveys were attempts to locate deposits of water-bearing sand and gravel from which large supplies of water could be obtained. The first survey was a joint effort by the Illinois Water Service Company of Champaign-Urbana and the University of Illinois searching for water supplies for both the cities and the University; the second survey sought a source of water for the University airport. In order that the latter area be examined in great detail, some 500 stations were occupied. Including the survey west of Champaign in the autumn of 1949, more than 1,100 stations have been occupied in this area.

State Geological Survey Division
Urbana, Illinois
UNIVERSITY of ILLINOIS TEST HOLE No. 3

R. 9 E. T. 19 N. Sec. 18

Elevation: 722 feet
Drilled 1934 by Layne-Western Co.

Studied 1934 by L.E.Workman
" 1949 by J.W.Foster

Champaign Co.
Sample Set # 1490

PLEISTOCENE	WISCONSIN STAGE (TAZEWELL SUBSTAGE) — Cerro Gordo Drift	70	5	5	Soil, dark brown, and silt, medium, yellow, non-calcareous
			5	10	Till, yellow-brown, oxidized, clayey, calcareous
			35	45	Till, gray, silty, calcareous, some pebbles
	Shelbyville Drift		5	50	Till, yellow-brown, very sandy, calcareous
			10	60	Till, brown, silty, sandy, calcareous
			10	70	Till, pinkish, silty, calcareous, some coarse sand
	SANGAMON INTERGLACIAL STAGE	20	5	75	Silt, brown, partly calcareous, and soil, dark brown, sandy
			10	85	Soil, dark brown, and silt, light brown, medium, calcareous
			5	90	Sand and silt, yellow, partly calcareous, some gravel
	ILLINOIAN STAGE	90	5	95	Till, gray, very sandy, gravelly, partly calcareous
			15	110	Sand, yellow, fine to coarse, poorly sorted, mostly dirty
			5	115	Silt, gray, fine, calcareous, possibly loess
			35	150	Sand, yellow, fine to coarse, high in quartz, mostly clean
			5	155	Sand, yellow, fine to medium, high in quartz, partly dirty
			10	165	Till, yellow-brown, very sandy, calcareous
			15	180	Till, reddish-brown, with pebbles, calcareous
	YARMOUTH INTERGLACIAL STAGE	50	5	185	Silt, gray, non-calcareous, some gravel
			5	190	Silt, brown, fine, calcareous, possibly loess
			25	215	Silt, brown, fine, calcareous, some pebbles
			15	230	Sand, yellow, fine to coarse, poorly sorted, dirty
	KANSAN STAGE	20	5	235	Till, reddish-brown, silty, sandy, calcareous
			15	250	Till, yellow, sandy, high in quartz, calcareous
	KANSAN INTRAGLACIAL Possibly AFTONIAN	35	35	285	Silt, reddish yellow, partly calcareous, some sand, scattered soil, some ashen green partly organic particles
	EARLY KANSAN or NEBRASKAN	5	5	290	Till, gray, clayey, silty, calcareous
PENNSYLVANIAN		4	4	294	Sandstone, yellow, fine, massive, coherent

FIG. 3. Summary sample study log of a Pleistocene geologic sequence.

The basic instrumentation (1) used in this work closely follows the commutated direct current circuits developed by O. H. Gish and W. J. Rooney using the Wenner configuration of electrode spacing. Many changes have been made in the instrumentation at the Illinois State Geological Survey, but the theory remains the same.

In field operation four equidistant electrodes are set in the ground in a straight line. Then a commutated 15 to 20 cycle current field is generated between the two outside steel electrodes and a measurement is made of the potential drop between the two inside copper electrodes. This measurement is observed on a specially calibrated potentiometer and is read directly in ohm-centimeters of apparent resistivity.

The spacing of electrodes, although not exactly indicative, is closely related to the depth to which the earth materials affect the resistivity value obtained. By setting the electrodes at successively closer spacings, successively shallower depths are penetrated. The instruments are portable but are normally operated along roads from the rear trunk of a passenger car. The surveys cannot be run where there are water or gas mains, steel post fences, or any type of a buried conductor which would disturb the applied electrical fields or the natural resistance of the earth materials.

In the Champaign-Urbana area electrical prospecting was carried out with the electrode configuration so established as to give fairly detailed resistivity measurements of the entire drift section. Drift thicknesses were estimated in advance of geophysical investigation.

In general, sands and gravels in the glacial drift bearing fresh water have considerably higher resistivities than non-water-bearing clays and silts; however, the amount of fine clay or silt present in sand and gravel has a direct effect on its resistivity, perhaps due largely to retarded flushing. It, therefore, follows that as the amount of clay or silt increases, the potential water yield and the resistivity value decrease. Where adequate geologic control has been established, it is sometimes possible to assign an arbitrary resistivity value which may be the lowest electrical value obtainable from good water-bearing, permeable sand and gravel. The Champaign-Urbana area is such an example.

In Figures 12 and 13, the glacial drift with resistivity values exceeding 8,000 ohm-centimeters is composed of clean sand and gravel deposits capable of producing large quantities of water. This has been proved by test drilling. In drift with resisitivity values ranging from 6,000 to 8,000 ohm-centimeters, sand and gravel deposits may be present, but are likely to have enough silt and clay to produce less water than the 8,000 ohm-centimeters drift. In drift with values of 4,500 to 6,000 ohm-centimeters, water supplies are rarely found. Resistivity values of 3,500 ohm-centimeters and lower in this area preclude the chance of getting even a satisfactory farm well. This interpretation has been demonstrated by drilling.

In some areas (Figs. 12 and 13) where high resistivity values were obtained no test drilling has been done; therefore, they remain probable but unproved areas.

Electric Logs.—The use of electric logs in studies of the glacial drift has supported sample-study logs, and has provided empirical data valuable in the exploration and development phases of groundwater research (1). Electric logs used in groundwater investigation usually provide the following information:

(1) Accurate depth determinations. The depths assigned to well cuttings, whether rotary or cable tool, are subject to error. Furthermore, the five-foot sample interval itself induces initial depth error. It follows that depth relationships of unconsolidated strata as determined by sample study alone are subject to some degree of error. The electric log indicates the electrical properties of strata with an accuracy that affords reliable depth determinations. During the development stage of a groundwater problem the use of electric logging therefore facilitates screen settings, shooting, and casing procedures.

(2) The qualitative determination of relative permeabilities. It has been pointed out by Knodle (7) that the true permeability of a glacial aquifer cannot be established from sample studies alone. Unconsolidated material once disturbed does not exhibit its former ability to transmit fluid. It is thought that the self-potential curve of the electric log represents an algebraic sum of several types of electrochemical potential. In the case of fresh-water sands the potential kick is generally positive. This is particularly true when the drilling mud contains in solution a sodium chloride content (usually from deeper saline waters) relatively greater than the sodium chloride content of the water of the aquifer (4).

In electric log interpretation of glacial drift in Illinois for the purpose of identifying zones of high permeability resistivity curves are very important. Zones of sand and gravel containing flushed, low mineralized groundwater exhibit greatest resistivity; zones of till and silt exhibit lower resistivity. On this basis the electric log of Figure 2 indicates (with greater detail and accuracy than the sample study) two zones in the drift section apparently capable of favorable groundwater percolation. These zones are at the depths of approximately 70–84 and 110–144 feet, respectively. Contrary to the sample study log the upper sand is probably the thinner of the two. The extremely high resistivity of a thin portion of the upper sand does not conclusively suggest that the upper sand is the more permeable of the two. There is likelihood that the lower sand because of high permeability was invaded by low resistivity drilling mud which would have the effect of masking the natural resistivity of the formation. Note that the third curve with its 53-inch electrode spacing reflects the influence of high resistivity sand over a greater vertical interval than the normal curve with its 18-inch electrode spacing. Note on the normal curve a high resistivity streak (probably a thin sand or bed of sandy till) at a depth of about 96–99 feet which did not strongly influence the third curve probably because of its wider electrode spacing.

(3) Correlation by electrical horizons. It has long been known that subsurface correlation by electrical characteristics is practical in indurated material. Peculiar electrical characteristics are known to occur also in unconsolidated glacial drift. The physical and chemical properties that control the

electrical characteristics cannot usually be detected by microscopic sample study. In such instances it remains for the electric log of undisturbed material to exhibit the electrical phenomena. The kick displayed by the normal resistivity curve of Figure 2 at a depth of about 50 feet may be caused by hole condition but is a type pattern that is a potential key to correlations. Glacial drift correlations by electrical anomalies are now in early stages in the Champaign-Urbana area, and final preparation awaits the availability of electric logs in critical localities.

(4) Detection of thin zones of permeability not exhibited by samples. Since samples from five-foot vertical intervals cannot illustrate the details of the geologic section many highly permeable sand or gravel beds of limited thickness may pass unobserved, unless the driller is extremely conscientious and competent. On the basis of permeability the electric log can facilitate the detection and possible development of this type of thin water-bearing bed.

THE BEDROCK SURFACE.

Character.—The mature Pennsylvanian-Mississippian bedrock surface of the Champaign-Urbana area (Fig. 4) has a maximum relief of about 305

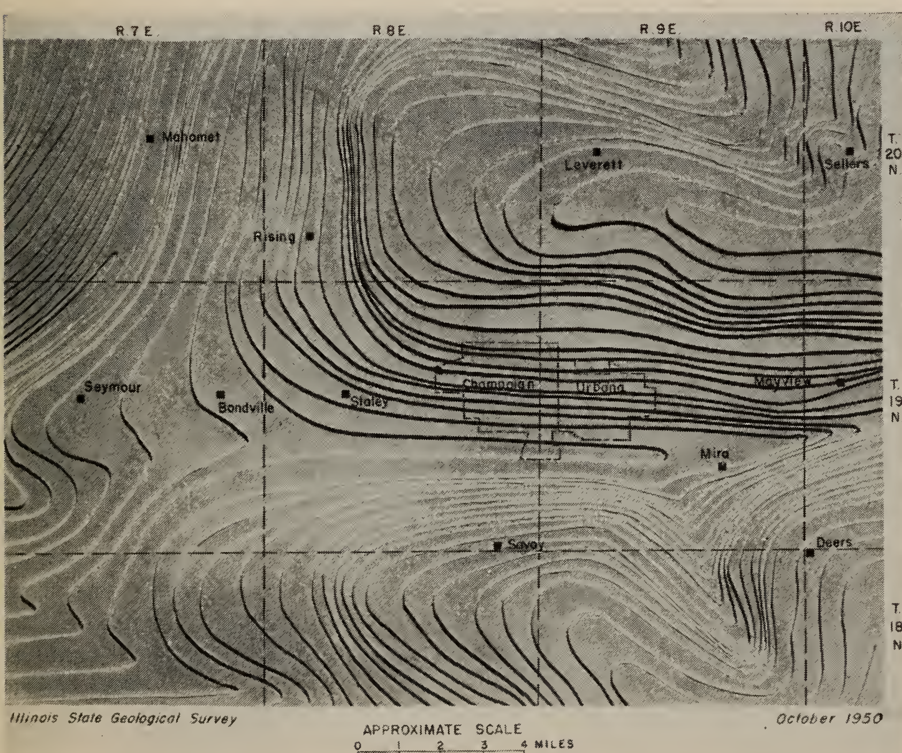

Fig. 4. Relief model of deeply buried bedrock topography with geographic superposition.

feet. All bedrock relief is completely obscured by the overlying drift mantles. The altitude of this bedrock surface ranges from approximately 300 to 605 feet. One of the dominant features here is the deeply entrenched Mahomet (5, p. 349), or lower Teays, Valley which crosses the northwestern portion of the area in a northeast direction. Above, and here largely east of, the Mahomet bedrock channel is a wide rock bench that ranges in elevation from about 400 to 475 feet. A well developed bedrock tributary valley trends west through the area and lies close to the south limits of Champaign. This tributary valley appears to open onto the rock bench near Bondville about 100 feet above the depths of the Mahomet Valley. Two high bedrock areas are located respectively north and south of the major west-running bedrock tributary valley. A bedrock elevation of 555 feet has been proved to the south in section 9, T.19 N., R.9 E. Maximum elevation of about 600 feet could be expected in section 17, T.18 N., R.10 E. A bedrock surface maximum elevation to the north appears to be about 570 feet in section 29, T.20 N., R.10 E. Outside of this area but within Champaign County bedrock elevations are probably locally as high as 620 feet above sea level.

Regional Relationship of Bedrock Surface.—The rock bench above the deep Mahomet channel was described as the Havana strath by Horberg (6, p. 190). Elevations of buried rock benches have been correlated from a point near the Indiana line to west-central Illinois in the southwestern corner of Mason County. This strath was probably a low drainage development post-dating the central Illinois Peneplain (6, p. 189). The bench surfaces lie on both sides of the Mahomet channel in Champaign County but are entirely east of the channel in the area described in this investigation. The strath areas deserve particular study since the rock benches appear to have had an important influence on the deposition of gravel deposits which have since become aquifers.

Below, and post-dating, the Havana strath the Mahomet channel lies within the confines of the strath west from Iroquois County. The depths of the valley represent the youngest major bedrock erosional development in the region. Indications are strong that the Mahomet River may have been the downstream channel of a vast drainage system extending from some point east of the Appalachian Front (along the west side of the Appalachian Valley) to the ancient Mississippi in western Illinois (5). Kansan and possibly older deposits in the deep valley suggest the abandonment and derangement of this vast drainage system in early Pleistocene.

One of the problems that arises in all considerations of the Teays-Mahomet bedrock valleys is the relationship of the Mahomet to the Wabash (3). The Mahomet and the Wabash bedrock valleys appear as downstream bifurcations of a single upstream valley. The abandonment of the Mahomet channel in Kansan time suggests that the chosen course of the lower Teays became the Wabash bedrock valley south of Tippecanoe County, Indiana. The Illinois lobe of the Kansan glacier apparently did not extend far into western Indiana, thus allowing the lower Teays River to be directed marginally along the east flank of the glacier. In south-central Ohio the north-flowing Teays

River apparently was reversed after Kansan glacial invasion (11, p. 78), which is evidence that the Wabash River was never a lower drainage course of the entire Teays system. The problem awaits further study of drill cuttings, particularly in Tippecanoe and Fountain Counties, Indiana.

The higher bedrock surfaces of the Champaign-Urbana area, specifically those above an altitude of 475 feet, are probably part of the Tertiary Central Illinois peneplain (6, p. 189). This has been described as the oldest erosional bedrock surface in the region.

PRE-GLACIAL UNCONSOLIDATED MATERIAL.

No drill cuttings of materials above the bedrock in the Champaign-Urbana area have been definitely assigned a pre-glacial origin, though elsewhere in the state (6, p. 190) pre-glacial unconsolidated material has been identified. However, there can be little doubt that limited thicknesses of non-glacial silt or sand and gravel are present on the bedrock surface in portions of the area. The material may be largely alluvial rather than residual, since alluvial deposits in protected locations in the bedrock lows would have more readily escaped ice scouring.

NEBRASKAN DRIFT.

Earlier studies of the drift in Illinois suggested the presence of glacial deposits older than Kansan (2, p. 124). Similar observations by subsurface methods have been made in the vicinity of Champaign. Figure 3 shows the summary sample study of the 294-foot University of Illinois test hole number 3, originally studied by L. E. Workman, Illinois State Geological Survey. The basal sample, which includes chips of Pennsylvanian sandstone from the bedrock, contains material that is unmistakably till. If the thick, highly weathered silt section, which here directly overlies the basal till is correctly identified as Aftonian, then the till resting on the bedrock is Nebraskan. The possibility must be entertained, however, that the basal till is early Kansan overlain by interstadial silt. No other samples in the Champaign-Urbana area have been so described.

The University of Illinois test hole number 3 is located on the north flank of the west-trending bedrock tributary valley which extends from south Urbana to the Havana strath. Sample studies of test holes nearer the axis of the bedrock valley suggest that Nebraskan till is not present on lower bedrock surface areas immediately south of test hole 3.

No deposits suggesting Nebraskan origin have been discovered from drill cuttings in the strath area west of Champaign. It could, perhaps, be expected that the surfaces of the bedrock bench were subjected to widespread erosion during the long Aftonian interglacial period. It is even more unlikely that major deposits of Nebraskan drift (if deposited) in the depths of the entrenched Mahomet Valley, could have survived the intense torrents in post-Nebraskan time. Nebraskan deposits, if present, do not by our present understanding warrant major consideration in the groundwater geology of the Champaign-Urbana area.

AFTONIAN SURFACE AND DEPOSITS.

Samples from only two test holes in the Champaign-Urbana area have been identified as interglacial Aftonian. These borings are the University of Illinois test holes numbers 3 and 1, located in sections 18 and 7, respectively, T.19 N., R.9 E., approximately 500 feet apart.

The Aftonian surface at the base of the Kansan drift section has been recognized here on the basis of a number of microscopic observations. (a)

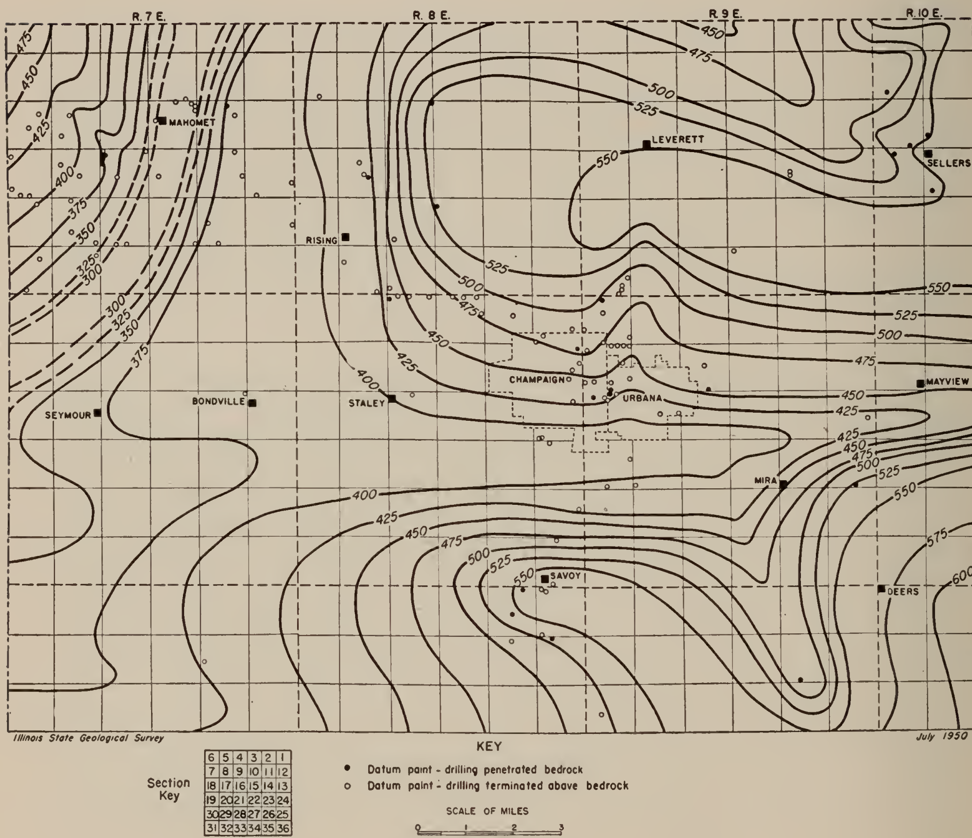

FIG. 5. Bedrock contour map of Champaign-Urbana area.

An abrupt lithologic change, generally to silt from basal Kansan sand, (b) strong oxidation, (c) organic silt, and (d) ashen green coloration of clayey silt particles.

Aftonian deposits are believed to occur at scattered places through the Champaign-Urbana area, probably concentrated in low bedrock elevations east of the Havana strath. Most of the deposits are strongly oxidized silt, possible in part loess. This silt section attains a thickness of 35 feet at the location of the University of Illinois test hole number 3. Coarse clastics

of Aftonian origin no doubt exist in the general vicinity of Champaign, but their recognition is difficult. It appears likely that Aftonian sands and gravels here are composed partly of reworked Nebraskan deposits. Since Nebraskan gravels may have a pebble suite distinct from Kansan in this area, it may be possible to distinguish Aftonian or Nebraskan gravels from those of Kansan origin. This approach has not yet been attempted here for lack of samples of coarse clastics of probable Nebraskan or Aftonian age.

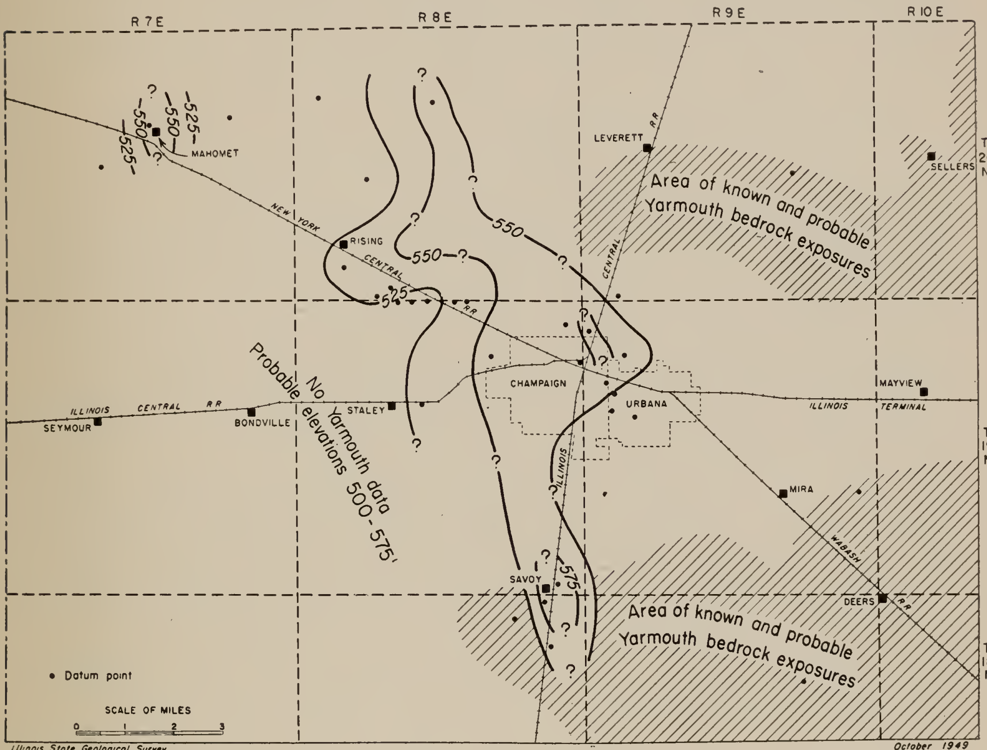

FIG. 6. Contour map of the top of Kansan drift showing the topography of the Yarmouth interglacial surface.

KANSAS DRIFT.

Drift of Kansan age rests on the bedrock surface through much of the Champaign-Urbana area, possibly overlying older unconsolidated Aftonian or Nebraskan deposits in extremely scattered and restricted locations. The Kansan drift surface, dissected by interglacial drainage and scoured by Illinoian ice, is overlain partly by Yarmouth soil and partly by younger glacial deposits.

Thickness and Distribution.—Drill holes have not penetrated either the greatest or the least Kansan drift thicknesses. However, several wells exhibit a Kansan section about 120 feet thick and terminate far above the extrapolated

elevation of the bedrock surface. The Kansan drift of maximum thickness is believed to lie in the vicinity of the Mahomet bedrock valley. It appears likely that Kansan drift completely fills the deep channel of the Mahomet Valley and most of the Havana strath. Kansan thicknesses probably range from zero to a maximum of about 250 feet over the lowest bedrock elevations west of Champaign.

Although available control by sample study justifies only tentative areal representation of Kansan distribution (Fig. 6) in general where bedrock surfaces are above an elevation of 500 feet Kansan deposits are not continuous. In many places where bedrock lies above 500 feet younger Illinoian drift rests on the bedrock surface. Above a bedrock elevation of 550 feet no Kansan drift has been identified here.

Lithology and Lithologic Distribution.—Kansan drift in the Champaign-Urbana area ranges in its composition from unsorted, ice-laid till to clean glacio-fluvial clastics. Although certainly not typical of much of Kansan drift elsewhere in the State, the general proportion of water-bearing sand and gravel to low permeability till is greater in the Kansan section than in overlying glacial deposits. The high proportion of sand and gravel is particularly evident within the general confines of the Havana strath.

The till is typically yellow-brown to gray pebbly silt, calcareous, with variable amounts of clay. Its distinction from Illinoian till by sample study is usually made by recognition of the stratigraphic sequence rather than by inherent differences in physical or chemical properties of the samples. Generally, Kansan till appears to lack the sandy characteristic of most Illinoian till in this area. Stratigraphically the Kansan till generally overlies the coarse Kansan clastics. However, future deep drilling in the Kansan drift over the Havana strath may discover unknown till in the basal Kansan section.

Coarse pre-Illinoian sand and gravel seems to lie in elongate masses concentrated over the low bedrock surfaces of the Havana strath west of Champaign. The beds range from well-sorted sand to sand and gravel and in lesser quantities to coarse well-sorted gravel. The long axes of these deposits are probably roughly parallel to the axis of the Havana strath, about south 10°–45° west in this area. Although the Kansan sand and gravel beds represent highly favorable groundwater aquifers, fine clastics have not been completely removed from all zones. Therefore, a gravel section commonly exhibits a great permeability range in a single vertical record.

The following Kansan sand and gravel thicknesses have been logged by sample study of Illinois Water Service Co. borings.

NW¼ section 21, T.20 N., R.7 E.	125 feet
NW¼ section 4, T.19 N., R.8 E.	140 feet
SE¼ section 32, T.20 N., R.8 E.	145 feet

Similar and greater thicknesses of coarse Kansan clastics probably lie in some locations over lower bedrock elevations. However, no borings within 30 miles of the Champaign-Urbana area have penetrated the deepest drift of the Mahomet channel. Although it appears likely that highly permeable sands, gravels (up to cobble size) lie in parts of the deepest portions of the bedrock valley, predictions to this effect must be made with a note of reservation.

Under certain glacial conditions, particularly those of ice stagnation, a bedrock channel may remain ice-choked while gravel accumulation of the terrace type occurs on the higher surfaces. There is a distinct possibility that a large portion of the deep channel is occupied by unsorted till and that the gravel deposits are largely confined to the upper part of the channel and to the Havana strath.

Aquifer Quality and Development.—High groundwater yield and continuing productivity of the deep Kansan aquifers west of Champaign have resulted from a number of geological phenomena:

1. Elongate form in a continuous bedrock valley.
2. Relatively great aquifer thickness.
3. Consistently high permeability along roughly horizontal planes.
4. Vertical hydrologic contact (in restricted areas) with overlying water-bearing gravels of Illinoian and younger age.

In the Kansan aquifers lie the most abundant available groundwater resources in the Champaign-Urbana area. Into these prolific deposits beneath the moraines and till plain west of Champaign recent development for municipal supply has progressed and will no doubt continue to progress as increased demands necessitate.

In addition to yield directed toward municipal use the Kansan aquifers afford a source of groundwater for many of the farms lying in the western portion of the Champaign-Urbana area. Such development, however, requires wells more than 200 feet deep in most areas. For this reason, where water quantity requirements are not enormous, shallower Illinoian or Wisconsin sands are tapped where possible.

Mode of Aquifer Deposition.—The unusually thick and extensive deposition of Kansan sand and gravel here can undoubtedly be attributed to proglacial or subglacial drainage concentrations in the Mahomet Valley. The presence in some places of ice-laid Kansan till overlying water-laid clastics suggests (1) that the elongate sand and gravel masses in the Havana strath accumulated subglacially and subsequently were covered by ice-dropped drift, or (2) that the coarse Kansan clastics are of the valley-train type, or possibly terrace type, spread by torrential proglacial drainage and later mantled with till from a Kansan glacier reinvasion.

YARMOUTH SURFACE AND DEPOSITS.

The Yarmouth interglacial surface which was developed partly on Kansan drift and partly on the bedrock appears to have been a gently rolling upland with a relief of about 100 feet. This relief in the Champaign-Urbana area was probably weakly representative of the bedrock topography. Although an observer of the region during Yarmouth time could probably have detected the locations of the bedrock highs, he would by casual inspection have been quite unaware of the great Mahomet Valley, because during Yarmouth time its position was marked only by a shallow sag in the drift surface.

Two areas in the vicinity of Champaign-Urbana northeast and southeast of the cities (Fig. 6) by reason of relatively high bedrock surface, probably had numerous bedrock exposures during the Yarmouth interval. The eleva-

tion of the Yarmouth surface on these bedrock highs was probably about 600 feet in limited areas. The apparent lack of Kansan material on the bedrock elevations above 550 feet is probably due to strong erosion by the Illinoian ice-sheet, and to long Yarmouth denudation, which must have been especially pronounced on these more exposed heights.

The existence of a depressed Yarmouth surface over the Havana strath may be due in part to subsidence and to compaction due to the weight of later ice, whereas the Yarmouth surface overlying higher bedrock would more adequately maintain its given elevation.

An elongate ridge in the Yarmouth surface trends north-south through Champaign and Savoy. This observation is based on the sample studies which record a Yarmouth elevation above 550 feet and locally above 575 feet. The ridge is apparently of the moraine type, as it is composed of Kansan till deposits. Absence of Yarmouth sample study data immediately south of Champaign precludes the possibility of describing now by this method the continuity of this Yarmouth land form. However, the ridge may have completely blocked the shallow sag which in Yarmouth time overlay the west-trending Champaign bedrock valley. Such a phenomenon would have resulted in temporary damming of Yarmouth drainage at this location. A Yarmouth silt deposit with a thickness of 30 feet has been described by L. E. Workman, State Geological Survey, in University of Illinois test hole number 8, section 18, T.19 N., R.9 E. The lake in which the silts were deposited was probably a temporary feature of the Yarmouth landscape.

Sample study reveals certain weathering characteristics of the Yarmouth interglacial period. Oxidation and leaching are commonly recorded, although it is not possible to assign thickness figures to weathered sections on the basis of five-foot samples. Yarmouth soil, like that of the Sangamon, is typically highly organic and dark brown. Woody structure is sometimes observed microscopically and less commonly megascopically.

ILLINOIAN DRIFT.

Intercalated between the Kansan and Wisconsin drifts and in some places between the bedrock and Wisconsin drift is a glacial deposit of Illinoian age. In the Champaign-Urbana area the Illinoian drift was spread with remarkable uniformity, deeply burying in most places the irregularities of the Yarmouth surface.

Thickness.—With an average of about 90 feet in this area the thickness of the Illinoian drift ranges from a minimum of less than 20 to a maximum of about 150 feet. Since the top of the Illinoian drift is a gently sloping plain in this portion of the state, Illinoian thickness here is controlled to a large part by the irregularities of the Yarmouth surface. Hence, the thinnest Illinoian drift lies over the high bedrock surfaces and the Kansan morainic ridge extending through Champaign and Savoy. The thicker Illinoian deposits, averaging about 110 feet, lie over the thick Kansan deposits filling the Havana strath and in the Yarmouth sag over the Champaign bedrock valley. Some known extremes in Illinoian thickness are as follows: Mattis test hole

number 1–1949, Sec. 7, T.20 N., R.8 E.—135 feet. University of Illinois test hole number 2–1944, Sec. 36, T.19 N., R.8 E.—15 feet.

Unmapped hills and depressions in the Yarmouth horizon, particularly over the Havana strath, may delineate other local extremes in Illinoian thickness. In addition, Sangamon drainage development probably reduced the thickness of the Illinoian section in a dendritic pattern largely unmapped at present.

Lithology and Lithologic Distribution.—Grey to buff pebbly silty till composes the basal and upper portions of the Illinoian drift section throughout

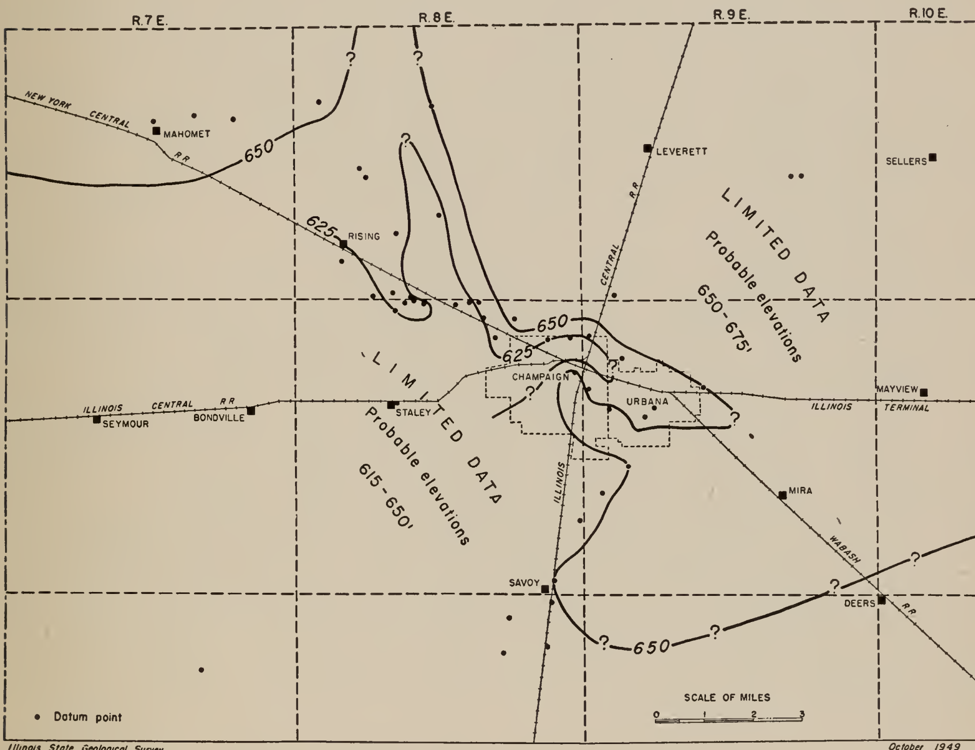

FIG. 7. Contour map of the top of Illinoian drift showing the topography of the Sangamon interglacial surface.

most of this area. Between these till sheets lies one or more remarkably persistent beds of coarse and partly clean sand and gravel. The middle Illinoian sand and gravel deposit pinches out entirely in some places. Illinois Water Service Company test hole number 34, section 6, T.19 N., R.9 E., shows a continuous section of till between the Sangamon and Yarmouth surfaces. However, from east Urbana west to the Mahomet area the great majority of deeper drift borings penetrate Illinoian sand and gravel, though not entirely clean. The coarse clastic beds range up to 75 feet in thickness.

Illinoian till is typically a sandy and gravelly buff silt which is separable on a textural basis in most places from the overlying Wisconsin and the underlying Kansan tills. Even more conclusive than texture in this distinction is color. The Illinoian lacks the pinkish hue so characteristic of the basal Wisconsin (Shelbyville) in central and western Champaign County.

Aquifer Quality and Development.—The following geologic factors appear to limit the favorability of the Illinoian aquifers of the Champaign-Urbana area: (1) Continuity is greatest in an east-west direction not parallel to the main axis of the bedrock valley system. Except in local areas the basal Illinoian till effectively isolates the middle Illinoian aquifers from the Kansan gravels in the Havana strath. For these reasons the Illinoian aquifers appear to be only in limited hydraulic contact with the deep Kansan gravels in the Havana strath. (2) The high Illinoian permeability evident in several test holes is not as extensive laterally as the pattern of sands might suggest. Complex facies changes and interfingering silt seems typical of the middle Illinoian sand and gravel deposits. It follows from these conditions that these aquifers are characterized by recharge restrictions and by generally less favorable aquifer properties.

One of the thicker masses of middle Illinoian sand and gravel occurs in northwestern Urbana. The first groundwater development for municipal use was made in this deposit. The aquifer was subsequently pumped above its optimum yield. Although pumping from this Illinoian aquifer is now only supplementary to the yield from the deeper Kansan gravels west of Champaign, the Illinoian aquifer has been moderately favorable since its discovery.

In the Champaign-Urbana area most of the farm wells of the drilled type penetrate Illinoian aquifers. These water-bearing formations are fully capable of satisfying extensive development for domestic purposes.

Mode of Aquifer Deposition.—Illinoian aquifers here are not restricted to a shoe-string pattern and therefore do not appear to have originated from confined drainage. Furthermore, the complex lithologic range in small areas observed in a given Illinoian aquifer suggest that the sands and gravels were spread as proglacial outwash along an active glacier front. Conditions of ice stagnation with interior drainage would probably have introduced more scattered, thicker deposits.

If the Illinoian aquifers are truly outwash deposits, then it must also be true that Illinoian readvance postdates the gravel deposition. The record of this second (possibly multiple) ice invasion is the mantle of upper Illinoian gravelly till which nearly everywhere in this area rests on the coarse clastics of the middle Illinoian section. No weathered zone has been observed between the gravels and the overlying till.

SANGAMON SURFACE AND DEPOSITS.

The Sangamon interglacial surface (Fig. 7), developed here in the interval between the Illinoian ice recession and the Tazewell ice invasion of Wisconsin time, has been regionally described by Horberg (5, p. 354) as a plain sloping gently away from the bedrock upland in McLean County.

The average elevation of the surface in the Champaign-Urbana area is

about 650 feet. The 650-foot contour apparently swings northward in the area west of Champaign and delineates a shallow sag extending north into extreme southern Ford County (5, p. 354). South of the 650-foot contour, elevations of the Sangamon horizon are below 625 feet in many places. The local gradient of the surface must be much more than the average gradient of the Sangamon plain through central Illinois.

The following criteria facilitate sample study recognition of the Sagamon surface in the Champaign-Urbana area:

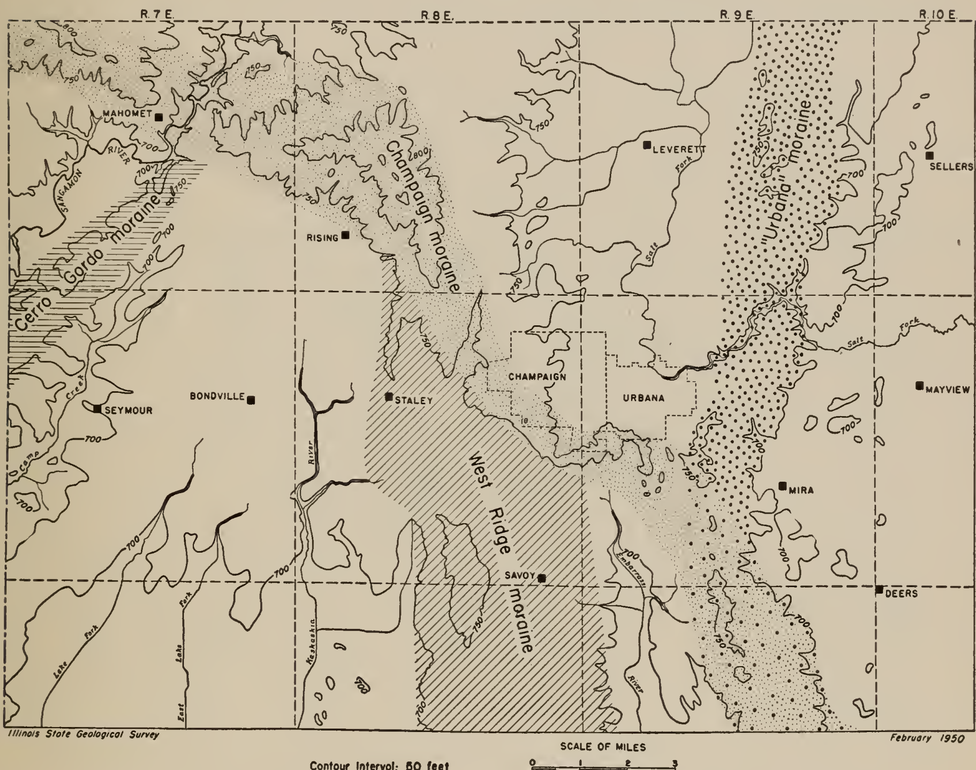

FIG. 8. Configuration of Wisconsin moraines and contour map of the ground surface.

(1) Buried soil at the anticipated stratigraphic horizon.

(2) An underlying Illinoian till evidencing chemical decay, or even gumbotil as in one of the Illinois Water Service test holes drilled in Dec. 1949, Sec. 36, T.20 N., R.7 E.

(3) A sharp break in the distinctive physical characteristic of the basal Wisconsin (Shelbyville) drift. This criterion may be indicative of an erosional unconformity, if the true Sangamon surface was destroyed.

Wisconsin glacial erosion in many cases has removed the zones of interglacial accumulation. Particles from these zones are commonly found in-

corporated in the basal Wisconsin till. Samples of these zones of reworked material have been provided by many borings, such as Illinois Water Service Co. test hole number 29–1948, Sec. 4, T.19 N., R.8 E. This test apparently intersected no Sangamon section, yet the extreme basal Wisconsin till contained soil and particles of leached Illinoian till. In these places the base of the Wisconsin drift does not represent the elevation of the Sangamon surface, and the true interglacial surface cannot be readily reconstructed.

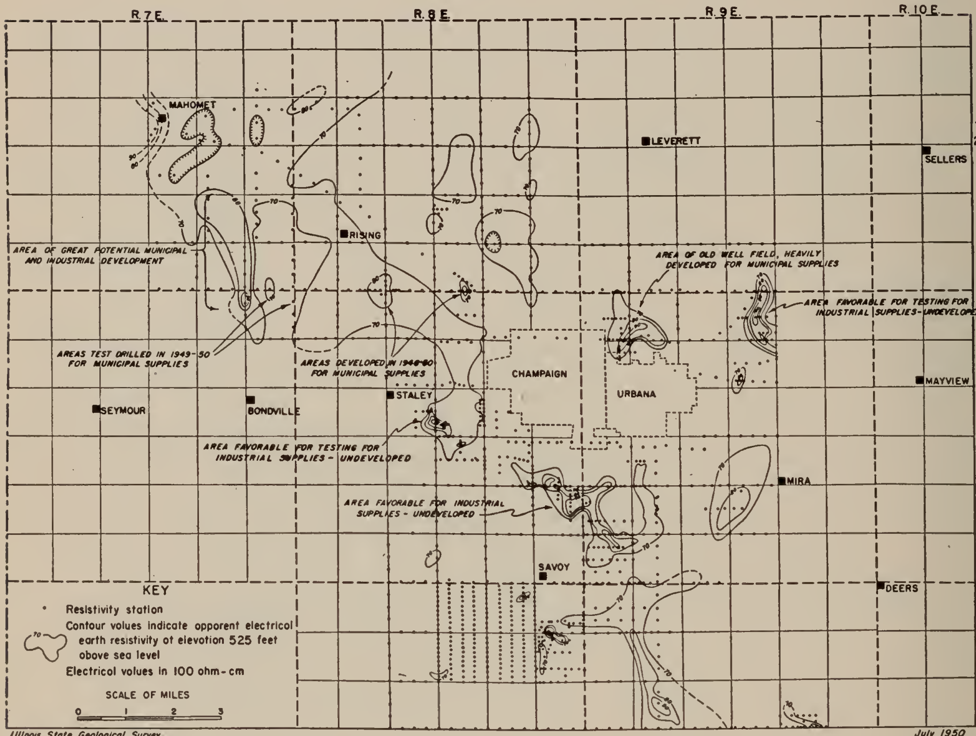

FIG. 9. Electrical earth resistivity contour and water resources procurement map.

WISCONSIN DRIFT.

Stratigraphic Position.—The Wisconsin (Tazewell) drift, the moraines and plains of which are geomorphic features of the present land surface, overlies the Sangamon interglacial surface here. Wisconsin drift in the Champaign-Urbana area is apparently composed of two to five stratigraphic units. The outcrops of these units are identifiable as moraines in and south of Champaign County (9, pp. 191–240; 8, p. 22). The basal drift was spread with remarkable uniformity here by the Shelbyville glacial lobe which in Illinois marked the southern extent of Wisconsin glaciation. It is overlain by Cerro Gordo drift of irregular thickness, associated with a later and more restricted Wisconsin lobate development, which lies between the Champaign-

Urbana area and the outer Shelbyville moraine (Fig. 8). Portions of the Cerro Gordo, West Ridge, Champaign, and "Urbana" [4] moraines in order of decreasing age, lie in area of this investigation. There are probably locations northeast of Urbana where drift sheets representing the five known moraines lie in orderly stratigraphic sequence. It has not been practical on the basis of drilling-samples from five-foot intervals to identify positively each of these units. However, the distinction between Shelbyville and Cerro Gordo drifts of Wisconsin age is readily made.

Thickness.—Wisconsin drift thickness in the Champaign-Urbana area ranges from probably less than 30 to 150 feet, as established by the undulations

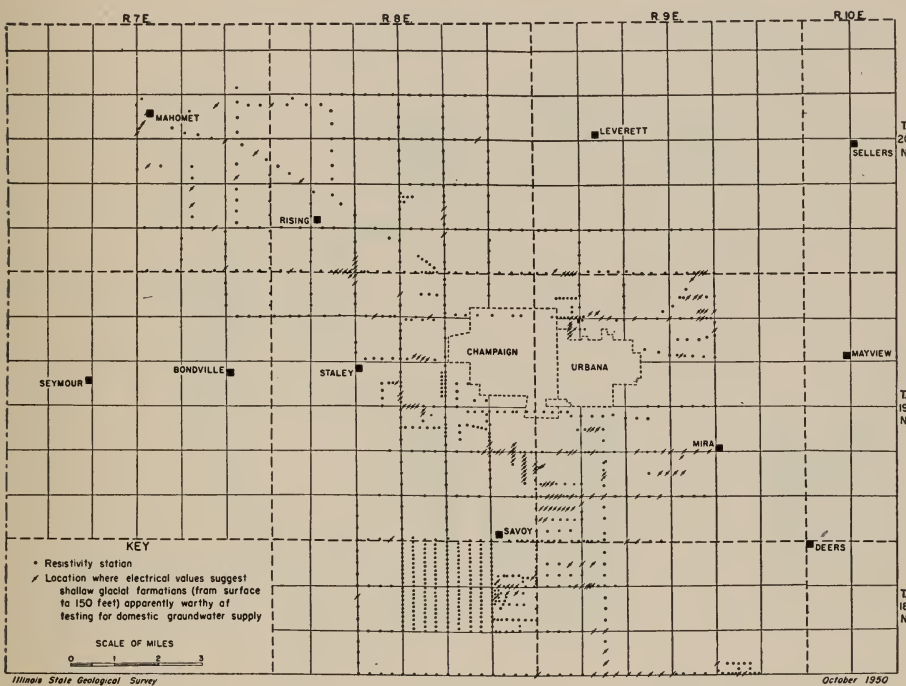

FIG. 10. Electrical earth resistivity map interpreted for shallow domestic groundwater procurement.

of the ground surface and by the irregularities of the Sangamon surface. The average thickness is about 80 feet. The greatest known Wisconsin thickness is in the vicinity of sections 3 and 4, T.19 N., R.8 E., approximately one and one-half miles west of the northwest corner of the present Champaign city limits. This is an area of high moraine overlying a well-defined sag in the Sangamon horizon. Samples from the following test borings are probably typical of the thicker Wisconsin accumulations: Illinois Water Service Co.

[4] Although "Urbana" is the title unofficially attached to this moraine, Dr. George E. Ekblaw, Illinois State Geological Survey, suggested that further physiographic and subsurface investigations may demand a more fitting name.

test hole number 26–1948, Sec. 3, T.19 N., R.8 T.—130 feet. Illinois Water Service Co. test hole number 28–1948, Sec. 4, T.19 N., R.8 E.—150 feet.

Large areas of Wisconsin cover are less than 70 feet thick. These are north of the moraines northeast of the 650-foot Sangamon contour (Fig. 7). Apart from this occurrence, an area restricted to the Sangamon Valley southeast of Mahomet has less than 30 feet of Tazewell drift. Although no Illinoian

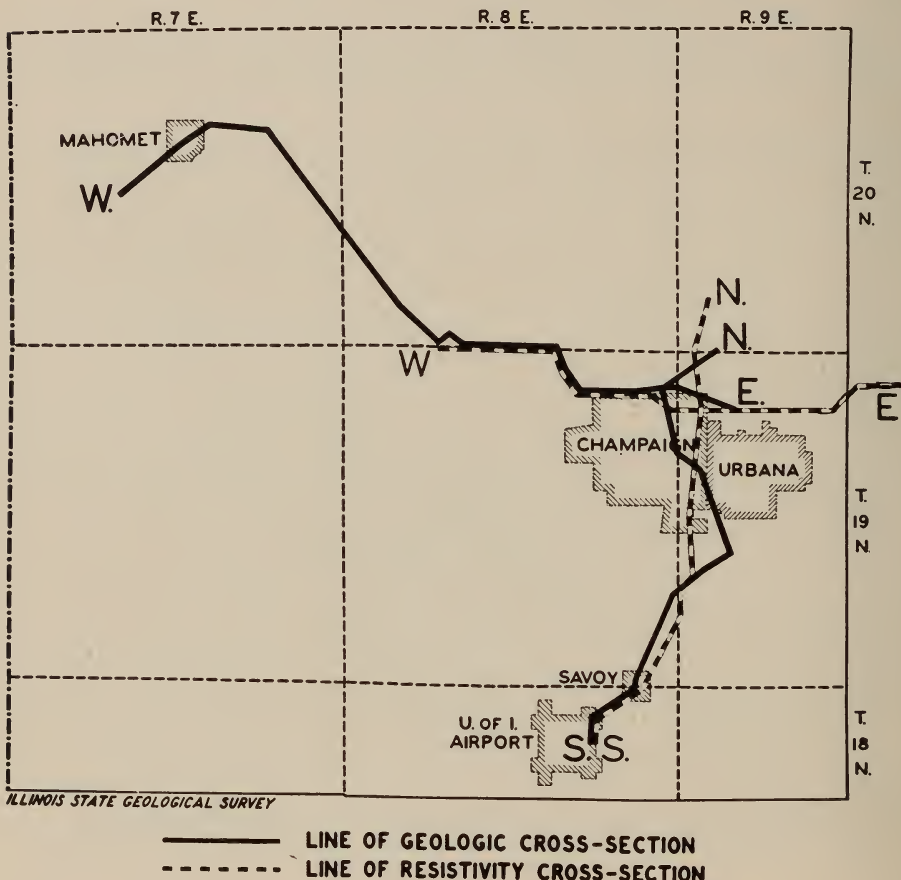

FIG. 11. Index map showing the trace of correlative geologic and electrical earth resistivity cross sections.

outcrops have been observed, it appears possible that the Wisconsin drift has been entirely eroded in some spots, perhaps along Salt Fork and West Branch Creeks northeast of Urbana and along the Sangamon River.

Physical Characteristics and Lithologic Distribution.—Below the zones of oxidation observed on the intra-Wisconsin drifts the tills are largely a grey-buff clayey silt with varying amounts of sand. A pinkish-brown color strongly characterizes the Shelbyville (basal Wisconsin) and is found else-

where stratigraphically only in the upper Illinoian. Supported by related data the pink color of the Shelbyville drift is a key horizon marker in the Pleistocene succession in the Champaign-Urbana area.[5]

Sand and gravel aquifers in the Tazewell drift in this vicinity are thin, lenticular, and scattered. To a large degree they are individually isolated by relatively impermeable till masses. Neither the absence of coarse clastics nor their abundance characterizes any one of the Wisconsin drift mantles, although the Shelbyville drift appears on the basis of present information to exhibit fewer aquifers than the overlying drifts. The Wisconsin sand and gravel lenses range up to several thousand feet in horizontal dimension. One

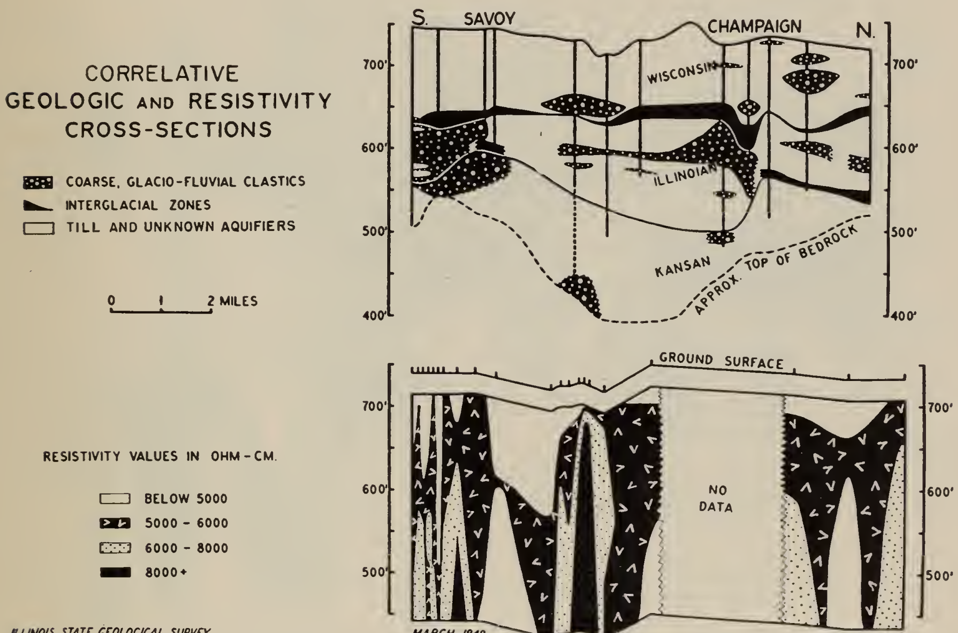

FIG. 12. Correlative geologic and electrical earth resistivity cross sections; south-north.

of the most extensive Wisconsin sand deposits lies superficial to the drift, along the valley of the Sangamon north and south of Mahomet, and has been developed commercially. This valley train deposit appears to be associated with thin, widespread and somewhat intermittent outwash which lies between the Sangamon and the Kaskaskia Rivers.

Aquifer Quality and Development.—By virtue of their isolation and lack of continuity the Wisconsin aquifers of the Champaign-Urbana area are not considered major sources of groundwater. Though permeabilities are in places known to be high, the till barriers to adequate groundwater recharge

[5] Northwest of Champaign County it is the younger Bloomington moraine which has the pink color so characteristic of the basal Wisconsin here.

appear to limit productive capacity in terms of municipal demands. Nevertheless, scores of highly satisfactory drilled wells on the farms of the Champaign-Urbana area terminate in Wisconsin sands. Many Wisconsin sands, some outlined by recent electrical earth resistivity surveying by the State Geological Survey, have never been drilled (Fig. 10).

Mode of Deposition of Aquifer Deposits.—Wisconsin sand and gravel concentrations in this area appear to fall into two classifications according to origin:

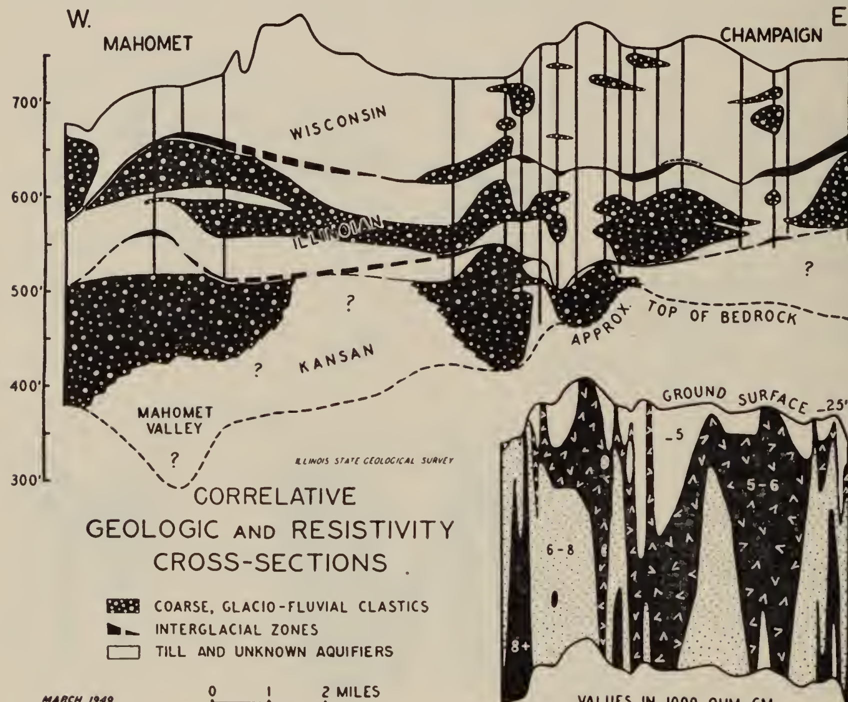

FIG. 13. Correlative geologic and electrical earth resistivity cross sections; west-east.

1. The sands that occur apparently at random within the Wisconsin drift may have originated from equally random fluvial activity with each glacial lobe. Under this group are included those sands, mostly small and lenticular, which occur within such stratigraphic units as the Shelbyville or Cerro Gordo drifts.

2. The sand and gravel accumulations associated with the Champaign glaciation are outstanding among the outwash type deposits of Wisconsin age. These deposits include the outwash veneer of silt and coarse clastics between the Sangamon and the Kaskaskia Rivers and the valley-train type concentrations restricted to the Sangamon Valley.

POST-GLACIAL DISSECTION.

Neither advanced headward erosion nor strong down-cutting characterizes the post-glacial history of the Champaign-Urbana area. More than 95 percent of the ground surface may be classified as undissected upland. This condition is in sharp contrast with broad areas immediately south of the Shelbyville moraine (65 miles south-southwest of Champaign), where the Illinoian drift retains less than 60 percent of its original upland surface.

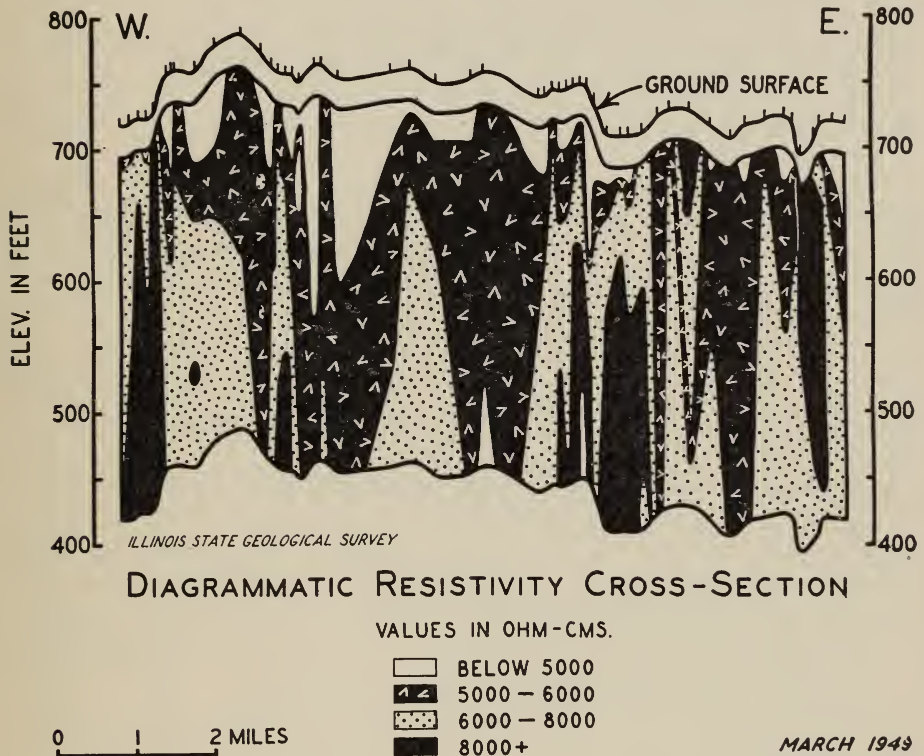

Fig. 14. Electrical earth resistivity cross section through area of no geological control; west-east.

The direct topographic influence on groundwater in the Champaign-Urbana area is as follows:

(a) Relatively slow surface run-off, permitting near-maximum penetration to the water table commensurate with drift permeability and evaporation factors.

(b) Glacial aquifers not subject to drainage by seepage along valley walls, with the exception of the Wisconsin valley-train deposits along the Sangamon River.

LOCAL AREAS OF RECHARGE OF DEEP AQUIFERS.

Because the deep beds of permeable sand and gravel in the Champaign-Urbana area are relatively flat-lying, the percolation of groundwater in response to pressure differential in these aquifers is probably principally along nearly horizontal planes. The horizontal interconnections of the Kansan aquifers over the low bedrock elevations of the buried Mahomet Valley may extend for many tens of miles. There is, however, considerable opportunity for surface recharge of these deep aquifers. In a few places there appears to be direct connection with the ground surface, where more or less chance deposition has placed permeable Illinoian and Wisconsin beds over the Kansan gravels. There must be still more places where percolation from the surface can reach the Kansan aquifers in step-like fashion, by-passing local deposits of impermeable till.

One area near Champaign-Urbana is believed on the basis of reliable samples to exhibit a continuous vertical section of sand and gravel from ground surface to the bedrock. This is located in the vicinity of the NW.¼ NW.¼ NW.¼, section 4, T.19 N., R.8 E. A log of Illinois Water Service Co. test hole C–2 1946 at the above location follows:

Sample Study by C. L. Horberg

Material	Thickness	Depth
Pleistocene series		
Wisconsin drift		
Soil, dark brown, non-calcareous, and sand, yellow, medium, silty	15	15
Sand, yellow, medium-coarse, silty, oxidized	5	20
Sand, yellow, medium-coarse, silty	55	75
Sand, yellow, coarse, silty	30	105
Illinoian and Kansan drift		
Gravel, yellow, coarse granular, oxidized	10	115
Sand, yellow, medium, silty, some gravel	25	140
Gravel, yellow, coarse granular, silty, some sand	25	165
Sand, yellow, medium, gravelly, trace of humus	40	205
Gravel, gray, coarse, varied lithology, silty below	55	260
Gravel, yellow, very coarse, clean, some sand	40	300
Pennsylvanian system		
Shale, gray, weak, some silt, calcareous	1	301 T.D.

In addition to the area near the common corner of sections 32 and 33, T.20 N., R.8 E. and sections 4 and 5, T.19 N., R.8 E., there may be other locations in the vicinity of Champaign-Urbana with a strong tendency toward percolation downward through the drift. These locations may be observed by comparison of Figures 9 and 10.

North of the Champaign-Urbana area a farm test hole drilled in January 1949, near the center of the NW.¼, section 23, T.21 N., R.7 E., showed a continuous sand and gravel section to the bedrock surface at a depth of 299 feet. This boring probably penetrated bedrock on the west flank of the Mahomet Valley.

SUMMARY.

Detailed geological and geophysical studies of the glacial drift have greatly extended the proved resources of groundwater available to the municipalities, industries, and farms of the Champaign-Urbana area. Geophysical methods used for these and similar studies throughout Illinois include electrical earth resistivity surveys on the ground surface and electric logs of bore holes. Geological methods included surface observations, subsurface studies of drill cuttings of nearly 100 drift borings, and sieve analyses of water-bearing formations.

Residents and industries of the Champaign-Urbana area have not always found themselves in favorable prospect for ample water. Due to the vastly increased war and post-war demand for groundwater and to hydrologic limitations of an old and highly developed well field in north Urbana, an alarming situation arose in 1945. The contour mapping of the bedrock surface of Illinois and the subsequent delineation of a major bedrock valley—the Mahomet or Lower Teays Valley—led to the discovery and exploitation of extensive water-bearing gravels west of Champaign.

Where reliable subsurface samples are available, stratigraphic glacial units of Kansan, Illinoian, and Wisconsin age, together with their pre-glacial, interglacial, and interstadial unconformities, are recognizable throughout a large portion of the Champaign-Urbana area. Kansan drift resting in the bedrock valleys and on the bench surfaces contains thick and widespread aquifers of great potential groundwater development. The overlying Illinoian drift exhibits favorable aquifers at many places, including the area of the old north Urbana well field. Due largely to unfavorable recharge conditions, these deposits are less favorable than the deeper Kansan gravels for concentrated groundwater development. Sands occurring in the relatively shallow Wisconsin drift are generally thin and scattered. Together with the underlying Illinoian aquifers they are well suited in many locations as sources of domestic groundwater.

CONCLUSIONS AND RECOMMENDATIONS.[6]

Municipal Groundwater Supplies (Fig. 9).—1. The most extensive deposits of glacial sand and gravel lie over the relatively low bedrock surfaces west and northwest of Champaign.

2. The numerous concentrations of probable and proved water-bearing sand and gravel beds lying north, east, and south of Champaign-Urbana do not appear to be large enough to support a continually expanding well-field development.

3. Sand and gravel beds in drift of Kansan age, now yielding groundwater to Illinois Water Service Company wells near the north boundary of sections 3, 4, 5, T.19 N., R.8 E. may warrant additional well construction.

4. The 1949 test borings by the Illinois Water Service Company on the north boundary of section 1, T.19 N., R.7 E. have proved the existence of

[6] For geographic locations of sites described in terms of Section, Township and Range see Fig. 9.

highly favorable Kansan sand and gravel beds in that area. These sands were earlier classified as "probable" on the basis of continuing geological and geophysical studies by the Illinois Geological Survey. These deposits definitely warrant well construction when groundwater demand requires it.

5. An extensive Kansan deposit of sand and gravel appears to lie in north-south orientation largely in the west portion of section 1, the east portion of section 2, T.19 N., R.7 E., the west portion of section 36, the east portion of section 35, and in section 23, T.20 N., R.7 E. This deposit is yet untested. The area appears to offer vast potential development.

6. It is doubtful that additional Kansan aquifers west of section 2, T.19 N., R.7 E. need be considered for Champaign-Urbana groundwater supply in the foreseeable future.

Industrial Groundwater Supplies (Fig. 9).—1. Numerous glacial sand and gravel concentrations in the Champaign-Urbana area appear worthy of consideration as sources of major industrial groundwater. Some of these concentrations are proved and are either now yielding groundwater or have been test drilled. Other concentrations probably exist, as suggested by electrical earth resistivity data.

2. Sand and gravel deposits particularly worthy of possible future investigation as sources of industrial groundwater lie principally in the following areas:

(a) Sec. 3, T. 19 N., R.9 E.
(b) Sec. 27, Sec. 28, T.19 N., R.9 E.
(c) Sec. 25, T.19 N., R.8 E; Sec. 30, Sec. 31, T.19 N., R.9 E.
(d) Sec. 8, Sec. 17, T.18 N., R.9 E.
(e) Sec. 15, Sec. 16, T.19 N., R.8 E.
(f) Numerous areas, partly unexplored, in T.20 N., R.7 E. and in the north portion of T.19 N., R.7 E.

3. Drilling for industrial groundwater in the Champaign-Urbana area should be preceded by joint conference with the State Geological Survey and the State Water Survey in order to consider all the geological, chemical, and hydrologic factors.

Domestic Groundwater Supplies (Fig. 10).—1. Glacial sands of sufficient thickness and extent to yield groundwater for domestic demand are abundant in the Champaign-Urbana area.

2. Shallowness of water-bearing drift deposits is especially important in domestic groundwater problems. Figure 10 indicates those electrical earth resistivity stations whose values suggest glacial sand formations shallower than 150 feet and apparently worthy of testing for domestic groundwater supply.

3. In many areas water-bearing deposits do not occur in the shallow portion of the drift. Test drilling in such locations should in most instances be extended to the bedrock surface in order to explore the entire thickness of the unconsolidated mantle.

Illinois State Geological Survey,
Urbana, Illinois,
Jan. 13, 1951.

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